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CLIMATE JUSTICE AND SOCIAL EQUITY IN INDONESIAN WATERSHED GOVERNANCE : THE CASE OF CITARUM

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ABSTRACT
This study explores how climate justice and social equity are integrated into watershed governance in Indonesia, using the Citarum River as a case study. It examines the progress and challenges faced by local communities and the government, as well as the policies implemented to achieve climate justice and social equity within a sustainable governance framework. Using a case study approach and qualitative methods, the findings highlight progress through initiatives such as the Citarum Harum program, which has facilitated renewable energy transitions, ecological restoration, and the adoption of Natural Climate Solutions (NCS), including the Citarum Living Lab program. However, findings also reveal that several challenges persist, including socio-political barriers, participatory limitations (especially from marginalized communities and non-governmental actors in decision-making), fragmented policy coordination, lack of stakeholder synergy, overlapping policies leading to inefficiencies, unequal resource distribution, and the increasing frequency of natural disasters that hinder inclusive governance. This study underscores the critical importance of integrating climate justice and social equity into Citarum Watershed governance to achieve environmental sustainability and improve the quality of life for local communities. It emphasizes the need to strengthen collaborative governance models, particularly through the Quintuple Helix framework, while ensuring inclusive decision-making. The findings provide valuable insights for policymakers to frame climate crises through the lens of climate justice and social equity, ensuring that sustainable watershed governance not only benefits communities in the Citarum Watershed but also contributes to broader societal well-being.

Keywords: climate justice; social equity; sustainable watershed governance; Citarum watershed; Indonesia

KEADILAN IKLIM DAN KESETARAAN SOSIAL UNTUK TATA KELOLA DAERAH ALIRAN SUNGAI YANG BERKELANJUTAN DI INDONESIA: STUDI KASUS DAS CITARUM

ABSTRAK
Studi ini mengkaji keadilan iklim dan kesetaraan sosial dalam pengembangan tata kelola daerah aliran sungai (DAS) yang berkelanjutan di Indonesia, dengan fokus pada Studi Kasus DAS Citarum. Penelitian ini mengeksplorasi kemajuan dan tantangan yang dihadapi oleh komunitas lokal dan pemerintah, serta kebijakan yang diimplementasikan untuk mencapai keadilan iklim dan kesetaraan sosial dalam kerangka tata kelola yang berkelanjutan. Dengan menggunakan pendekatan studi kasus dan metode kualitatif, temuan penelitian ini menunjukkan adanya kemajuan melalui berbagai inisiatif seperti Program Citarum Harum, yang telah mendorong transisi energi terbarukan, restorasi ekologi, dan adopsi *Natural Climate Solutions* (NCS), termasuk program *Citarum Living Lab*. Namun demikian, masih terdapat sejumlah tantangan yang signifikan, seperti fragmentasi sektoral, partisipasi yang terbatas dari komunitas terpinggirkan dan aktor non-pemerintah dalam pengambilan keputusan, kurangnya sinergi antar pemangku kepentingan, kebijakan yang tumpang tindih yang menyebabkan inefisiensi, distribusi sumber daya yang tidak merata, serta meningkatnya frekuensi bencana alam. Studi ini menegaskan pentingnya integrasi keadilan iklim dan kesetaraan sosial dalam tata kelola DAS Citarum guna mencapai keberlanjutan lingkungan dan meningkatkan kualitas hidup masyarakat setempat. Penelitian ini juga menekankan perlunya penguatan model tata kelola kolaboratif, khususnya melalui kerangka *Quintuple Helix*, dengan memastikan pengambilan keputusan yang inklusif. Temuan ini memberikan wawasan berharga bagi para pembuat kebijakan dalam merumuskan respons terhadap krisis iklim melalui lensa keadilan iklim dan kesetaraan sosial, sehingga tata kelola DAS yang berkelanjutan tidak hanya memberikan manfaat bagi masyarakat di DAS Citarum, tetapi juga berkontribusi pada kesejahteraan sosial yang lebih luas.

Kata kunci: keadilan iklim; kesetaraan sosial; tata kelola daerah aliran sungai yang berkelanjutan; DAS Citarum; Indonesia

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INTRODUCTION

Indonesia is a country highly vulnerable to the impacts of climate change, with increasing susceptibility to natural disasters and ecosystem degradation (BMKG, 2024). Climate change in Indonesia is marked by rising average temperatures, significant sea level anomalies, and an increase in the frequency of natural disasters such as floods and forest fires. Data from BMKG indicate that throughout 2024, the monthly average temperatures in Indonesia have consistently been above normal, with October being the hottest month, showing an anomaly of 0.82°C compared to the normal period of 1991-2020 (BMKG, 2024). Additionally, sea level rise has been recorded at approximately 4.3 mm per year, based on satellite data (BMKG, 2024). The increase in disasters is also evident in Indonesia, where 2,775 disaster events were recorded in 2021, the majority of which were caused by hydrometeorological disasters such as floods (1,159 events), extreme weather (695 events), and landslides (563 events) (Arifin et al., 2023). One of the areas affected by climate change in Indonesia is the watershed, such as the Citarum Watershed, which faces major challenges in water resource management due to pollution, environmental degradation, and climate change (Primadita et al., 2022).

Meanwhile, the UNDP emphasizes that certain groups, such as women, indigenous peoples, and individuals with disabilities, are more vulnerable to the impacts of climate change due to existing structural inequalities within society (UNDP, 2023). This underscores the close relationship between climate justice and social justice. Climate change can exacerbate existing social inequalities, and conversely, social injustice can make communities more vulnerable to the effects of climate change.

In this context, Indonesia faces a significant challenge in ensuring that climate change mitigation and adaptation efforts not only focus on technical and environmental aspects but also take into account social justice for all layers of society (BMKG, 2024). Therefore, it is crucial for Indonesia to implement climate justice and social equity as integral components of climate policy. By ensuring that all segments of society, especially the most vulnerable, have fair access to resources and protection from climate impacts, Indonesia can minimize the resulting effects and build a more inclusive and sustainable future.

Meanwhile, climate justice refers to the principle that the impacts of climate change should not be distributed unfairly, and that countries and individuals most responsible for greenhouse gas emissions should bear a larger share of the burden in mitigation efforts (Schlosberg, 2012). In Indonesia, climate justice includes efforts to protect the most vulnerable communities, such as indigenous peoples, fishermen, and small-scale farmers, who often contribute the least to global warming but bear the greatest impacts, such as floods, droughts, and ecosystem degradation (Agyemang & Evans, 2015).

Social equity in Indonesia refers to the fair distribution of access to resources, economic opportunities, and social rights for all citizens. Amidst significant social inequality, social equity demands equal opportunities in terms of access to education, healthcare, and other basic services, as well as reducing disparities between wealthy and poor regions, especially between the more developed Java and the less developed areas in Eastern Indonesia (BPS, 2020; Suwarno, 2019). Social equity also calls for policies that address social diversity and ensure fair access to the benefits of development for all layers of society (Schlosberg, 2012). In the context of watershed management, social equity is crucial for ensuring that marginalized communities have a fair voice and participation in decision-making processes that affect their access to water resources and land management (Schlosberg, 2012).

Watersheds play a crucial role in ecological systems by regulating water flow, supporting biodiversity, and ensuring the sustainability of natural resources. They provide essential ecosystem services, such as water storage, flood mitigation, and agricultural irrigation, which are vital for human livelihoods (Pande, 2020; Singh & Basu, 2022). However, watersheds worldwide, including in Indonesia, face significant challenges due to anthropogenic activities and ecological pressures such as deforestation, pollution, soil erosion, sedimentation, and land-use changes (Widianingsih, et al. 2021; Narendra et al., 2021). These issues threaten the sustainability of watersheds, impacting not only the environment but also social and economic stability (Narendra et al., 2021).

Research shows that the Citarum Watershed is not immune to the impacts of climate change. In addition to being heavily polluted and experiencing environmental degradation, it has been labeled as one of the most polluted rivers in the world due to excessive industrial, domestic, and agricultural waste. The Citarum Watershed is also experiencing changes in temperature, evaporation, and relative humidity. In Cirata Reservoir, between 1998 and 2011, the temperature increased by 1°C, with a change rate of +0.3% per year. Evaporation rose by 0.002, or +0.0003% per year, and relative humidity decreased by 0.25, or -0.032% per year (Primadita et al., 2022).

In projections based on seven GCM RCP8.5 models, rainfall distribution from 2006 to 2015 was relatively normal. However, the projection indicates that rainfall will become drier by 55% from 2016 to 2025, wetter by two times during 2026-2035, and significantly drier by up to three times during 2036-2045. Analysis of daily rainfall suggests that rainfall intensity is expected to increase, but with fewer rainy days. The number of dry days will increase, and when it does rain, the intensity will be higher than normal. These changes significantly increase the likelihood of both flooding and drought, and the amount of water in the river is projected to become more fluctuating (Primadita et al., 2022).

The Citarum Watershed is a vital national asset, supplying electricity to the nation and meeting the water needs for agriculture in various major cities, as well as providing potable water to the capital city. This watershed spans 297 km, supplying water to over 25 million people and supporting various sectors, including agriculture (328,425 hectares of irrigation), hydropower generation (2,600 MW), and urban water supply (providing 80% of DKI Jakarta's water source) (Bappenas, Kemenkomarves, Kementerian PUPR, 2024; Satgas PKK DAS Citarum, 2019). Despite its importance, the Citarum Watershed faces numerous risks from climate change, particularly in terms of water availability. The sub-watersheds at high risk include Citarum Hilir, Cipamingkis, Cisangkuy, Cirata, and Cihaur. Regarding flood risk, the most vulnerable sub-watersheds are Citarum Hilir, Cipamingkis, Cibeet, Cisangkuy, and Citarum Hulu. For drought risk, the most vulnerable areas include Citarum Hilir, Cipamingkis, and Cisangkuy (Primadita et al., 2022).

Government-led programs such as Prokasih, Citarum Bestari, ICWRMIP, and Citarum Harum have attempted to rehabilitate the watershed. However, significant challenges remain in ensuring equitable and sustainable governance (Bappenas, Kemenkomarves, Kementerian PUPR, 2024; Satgas PKK DAS Citarum, 2019).

Climate Justice and Social Equity in Watershed Governance

In watershed governance, the principle of Integrated Water Resources Management (IWRM) (an approach that manages all aspects of water use in an area, considering rivers, lakes, groundwater, and reservoirs to ensure water is used wisely, fairly, and sustainably), emphasizes three main pillars: social equity, economic efficiency, and environmental sustainability (Global Water Partnership, 2012; Peña, 2011). In the context of the Citarum Watershed, the implementation of social equity means ensuring equal access to water and its benefits for all groups, including women, the poor, and marginalized communities (Lenton & Muller, 2009). This equity also encompasses the right to a clean and healthy environment, which is a fundamental aspect of improving community well-being.

The intersection of social equity and climate justice is particularly crucial in the Citarum Watershed, where marginalized communities face disproportionate consequences due to both environmental degradation and governance inefficiencies (Caballero-Anthony & Ishikawa, 2023; Ibrahim & Kartasasmita, 2017). Many of these communities depend on the river for their livelihoods and daily needs, yet they have limited means to adapt to worsening pollution and water scarcity (Caballero-Anthony & Ishikawa, 2023; Ibrahim & Kartasasmita, 2017). Addressing these challenges requires governance approaches that prioritize inclusivity, resilience, and equitable resource distribution.

Climate justice underscores the need for fair resource distribution and recognition of the rights of those most affected by environmental degradation (Newell & Mulvaney, 2013). As noted by Barriors et al., effective watershed management strategies must integrate a holistic approach that considers the social, economic, and ecological functions of watersheds, especially in the face of climate change (Barriors et al., 2024). This aligns with the study of Roy & Berke (2022) who argue that equitable watershed management requires an institutional framework that addresses the distributive consequences of environmental hazards, thereby promoting social equity. Moreover, incorporating social context variables into watershed management programs can significantly enhance their effectiveness. Prokopy et al. emphasize the importance of understanding social dynamics within watershed communities, as these factors can influence the success of management strategies (Prokopy et al., 2010). By acknowledging and addressing these social factors, watershed governance can become more inclusive and equitable, ultimately leading to better environmental outcomes.

While many studies have focused on watershed degradation and management, there remains a critical gap in understanding the intersection of climate justice and social equity in watershed governance. Previous research has explored the impacts of climate change on Citarum watersheds, highlighting highlighting rising temperatures and changes in rainfall patterns, increased potential for natural disasters such as floods, landslides, river overflows, and the spread of diseases (due to increased rainfall), as well as droughts, crop failures, and water shortages (due to decreased rainfall) (WWF-Indonesia, 2007; Primadita et al., 2022). However, fewer studies have examined

how governance frameworks can integrate justice principles to ensure that marginalized communities receive fair access to water resources and are not disproportionately affected by environmental degradation (Dobbin & Lubell, 2021; Rodina, 2020).

Comparative cases, such as the Mekong River and the Ganges River, illustrate similar challenges. For example, Keovilignavong et al. (2023) found that hydropower projects in the Mekong have disrupted water flow patterns, threatening biodiversity and downstream agriculture. Similarly, Pathak & Mishra (2020) reported severe pollution in the Ganges due to domestic, industrial, and religious activities, leading to health and environmental crises. Climate change further exacerbates these issues by altering rainfall patterns, increasing the frequency of floods and droughts, and accelerating glacial melt in the Himalayas, which feeds both the Mekong and Ganges (Pathak & Mishra, 2020; Dudula & Randhir, 2016).

A just and sustainable watershed governance model must integrate climate resilience strategies while prioritizing the needs of the most vulnerable communities (Cosens & Gunderson, 2018; Sultana, 2021; Gupta & Lebel, 2020). By embedding climate justice and social equity in watershed governance, policies can address systemic inequalities, empower marginalized groups, and enhance overall ecosystem resilience (Sultana, 2021; Cheng, 2016, Foster & Iaione, 2022). This study seeks to explore how these principles are applied in the governance of Citarum Watershed and their implications for sustainable water management.

In the case of Citarum Watershed, the socio-environmental challenges are exacerbated by economic disparities, governance inefficiencies, and conflicting interests among stakeholders. Therefore, this study seeks to bridge the gap in understanding how climate justice and social equity can be integrated into sustainable watershed governance.This study aims to analyze the progress and challenges faced by local communities and government agencies in achieving climate justice and social equity in Citarum Watershed governance.The findings of this research are expected to provide insights for policymakers on addressing climate change from a climate justice and social equity perspective and contribute to the broader discourse on environmental justice by highlighting the role of governance structures in ensuring fair and inclusive access to water resources.

METHOD

This study is grounded in the interpretive social science tradition, which emphasizes understanding the lived experiences, perspectives, and social interactions of stakeholders involved in the governance of the Citarum Watershed. By utilizing a case study approach and qualitative methods, this study aims to explore climate justice and social equity within the framework of sustainable watershed governance, focusing on the Citarum Watershed. According to Creswell & Poth (2018), a case study is a qualitative method in which researchers examine one or more bounded systems (cases) over time, collecting extensive detailed information from multiple sources such as interviews, Forum Group Discussion, documents and official reports from the Government, and literature studies. The data sources for this research consist of both primary and secondary data obtained through comprehensive interviews, focus group discussions, government documents, and literature studies.

The data collection process includes in-depth interviews with key stakeholders involved in strategic development in Citarum Watershed. The interviews were conducted in Bandung City between in September to December 2024. In-depth interviews were conducted with government officials, community leaders, private sector representative, representatives from non-governmental organizations (NGOs), and academic representative to gather diverse viewpoints on climate justice and social equity in the Citarum Watershed. Interviews were carried out both in-person and online, ensuring broad participation across key stakeholders." The respondents included key community figures, as follows: 1. Head of the Task Force for Integrated Watershed Pollution and Damage Control (SATGAS PPK DAS Citarum); 2. Expert Team of SATGAS PPK DAS Citarum; 3. Head of the Integrated Water Resources Infrastructure Development Program (KPISDA) – Citarum River Basin Management Office (BBWS); 4. Non-Governmental Member of Citarum Watershed Coordination Team (TKPSDA WS Citarum) (NGO - Local Resource Development Institute West Java); 5. Non-Governmental Member of Citarum Watershed Coordination Team (TKPSDA WS Citarum) (Executive Secretary of the Indonesian Employers Association (DPP APINDO) West Java); 6. Non-Governmental Member of Citarum Watershed Coordination Team (TKPSDA WS Citarum) (Academic Representative – Pasundan University). The data collations and data sources of the primary data are presented in Table 1.

The selection of stakeholders was guided by their involvement in decision-making processes and their expertise in watershed governance, environmental justice, and community engagement in the Citarum Watershed. Stakeholders were chosen to represent a diverse range of perspectives, ensuring a comprehensive understanding of the governance dynamics at play.

Data Analysis

The data analysis technique used in this study follows an interactive model, as proposed by Miles, M.B. et al. (2018). The interactive model consists of four main analytical components: data collection, data reduction, data display, and conclusion drawing.

In this study, data collection was conducted through interviews with community members and relevant stakeholders, literature reviews, including government documents and secondary data sources. After data collection, the researchers assessed and categorized key issues, such as implemented policies, roles, interactions, and stakeholder engagement. Irrelevant data, such as those discussing off-topic issues, were discarded (data reduction).

The authors then organized interview results and other collected data into tables or graphs to highlight patterns, such as agreements or differing opinions among stakeholders on watershed management policies and their respective roles and involvement. The final analysis was conducted using an interactive approach combined with various analytical techniques, culminating in the conclusion drawing.

Theoritical Framework

In this study, the conceptual framework of climate justice is applied to watershed governance in Indonesia, using the Citarum Watershed as a case study. In this study, climate justice is applied to governance in the Citarum Watershed, drawing from key theoretical concepts. The concept of Just Transition (Center for Climate Justice, 2024) emphasizes that the transition to a low-carbon economy should be fair and inclusive, providing support to communities impacted by environmental change. In the Citarum Watershed, this involves reducing reliance on destructive practices and offering sustainable economic alternatives.

Additionally, Social, Racial, and Environmental Justice (Adger, 2003) highlights the need for fair distribution of resources and equal opportunities, especially for marginalized communities such as the poor, women, and indigenous groups. For Citarum, this means ensuring equitable access to resources and climate adaptation opportunities for all.

The theory of Community Resilience and Adaptation (Adger, 2003) stresses the importance of community involvement in decision-making to increase adaptive capacity. In the Citarum Watershed, this includes engaging local communities in risk mapping and adaptation strategies for frequent disasters like flooding and droughts.

Natural Climate Solutions (Griscom et al., 2017) and Climate Education advocate for nature-based solutions, such as forest restoration and sustainable land management, as well as educating communities on climate impacts and mitigation. In Citarum, this can involve wetland restoration and improved forest management to reduce floods and enhance carbon storage.

Integrating these theories provides a comprehensive framework for climate justice in Citarum Watershed governance, ensuring that vulnerable groups have equal opportunities to adapt to and benefit from sustainable climate solutions. Considering the geographical conditions, situation, and relevance to this case study, the climate justice framework focuses on indicators such as Just Transition (Center for Climate Justice, 2024); Social, Racial, and Environmental Justice (including the Right and Access to Resources Needed and Equal Chance of Survival) (Adger, 2003); Community Resilience and Adaptation (including Participation and Consultation) (Adger, 2003); and Natural Climate Solutions and Climate Education and Engagement (Center for Climate Justice, 2024; Griscom et al., 2017).

Meanwhile, the social equity framework focuses on the following indicators: 1) Stakeholder Involvement and Participation (including all groups, regardless of socio-economic status) (Arnstein, 1969; Pena, 2011); 2) Equitable Distribution of Benefits and Burdens (prioritizing needs and principles recognized as basic and ethical by society) (Rawls, 1999; Pena, 2011); 3) Equitable Participation in Decision-Making Processes (participation in planning, governance, and outreach to marginalized groups) (Reed, 2008; Pena, 2011); 4) Livelihood Enhancement and Community Resilience (Berkes & Folke, 1998); and 5) Institutional Arrangements and Governance Structures (Ostrom, 1990).

In this study, both climate justice and social equity frameworks are applied to watershed governance in the Citarum Watershed. Climate justice addresses the fairness of climate impacts, while social equity ensures the fair distribution of climate action benefits, particularly for marginalized groups. Climate change disproportionately impacts vulnerable communities, exacerbating existing inequalities and health disparities (Gould & Rudolph, 2014), particularly in regions like the Citarum

Watershed, where these groups are at higher risk from climate-induced disasters.

While climate justice focuses on the environmental impacts of climate change, social equity ensuring that the governance processes are inclusive and provide equal opportunities for all members of society. However, some argue that focusing on one may neglect the other. Prioritizing climate justice could overlook social inequities, while focusing solely on social equity might fail to address the underlying climate risks (Schlosberg, 2012; Heyen, 2023). By integrating both frameworks, this study aims to provide a comprehensive approach to governance in the Citarum Watershed, addressing both environmental and social dimensions of climate change.

Table 1. Data Collations and Data Sources

Issues	Data Collations	Description	Informants
The progress and challenges of Climate Justice and Social Equity in Citarum Watershed	In-depth Interviews	6 Informant Interview data, the primary data of this study, was collected through face-to-face, online interview, and paper interviews with 6 interviewees.	1. Head of the Task Force for Integrated Watershed Pollution and Damage Control (SATGAS PPK DAS Citarum); 2. Expert Team of SATGAS PPK DAS Citarum; 3. Head of the Integrated Water Resources Infrastructure Development Program (KPISDA) – Citarum River Basin Management Office (BBWS); 4. Non-Governmental Member of Citarum Watershed Coordination Team (TKPSDA WS Citarum) (NGO - Local Resource Development Institute West Java); 5. Non-Governmental Member of Citarum Watershed Coordination Team (TKPSDA WS Citarum) (Executive Secretary of the Indonesian Employers Association (DPP APINDO) West Java); 6. Non-Governmental Member of Citarum Watershed Coordination Team (TKPSDA WS Citarum) (Academic Representative – Pasundan University).
Climate Justice Data: 1) Just transition; 2) Social, racial, and environmental justice; 3) Community resilience & adaptation; 4) Natural climate solutions, climate education, & engagement. **Social Equity Data:** 1) Inclusive participation; 2) Equitable resource distribution; 3) Gender equality in watershed management; 4) Community capacity building; 5) Transparency & accountability; 6) Conflict resolution mechanisms; 7) Community resilience & adaptation; 8) Collaborative frameworks.	Primary Data: a Focus Group Discussion (FGD) and a Workshop	**a. Focus Group Discussion: Evaluation of Waste Mitigation in the Citarum River,** held on November 12, 2024, attended by all stakeholders. **b. Workshop: "Towards Policies for River Revitalization: Film Screening Discussion and Citarum Living Laboratory Exhibition,"** held on November 13-14, 2024, at the Citarum Task Force Office – in collaboration with Citarum Task Force Monash University, the University of Indonesia, and partners.	a. This event was attended by representatives from the Provincial Government, representatives from Bandung Regency Government, BBWS, the Indonesian National Armed Forces (TNI), the Indonesian National Police (Polri), various community organizations and NGOs, 10 representatives of village heads from Bandung Regency, the Head and Expert Team of the Citarum Watershed Pollution and Damage Control Task Force (SATGAS PPK DAS Citarum), and academics from Pasundan University, Padjadjaran University, and others. **b. This event was attended by the following panelists and speakers:** Dean of the Faculty of Social and Political Sciences, University of Indonesia; 2) Unit Manager of Knowledge to Partnership Unit, DFAT; 3) Executive Chairman of the Citarum Harum Juara Task Force; 4) Director of Informal Cities Lab, Monash Art, Design & Architecture, Monash University; 5) Head of the Hydraulic, Hydrology, and River Laboratory, University of Indonesia; 6) Director of the Center for Political Science, University of Indonesia 7) Senior Researcher, Commonwealth Scientific and Industrial Research Organisation (CSIRO); 8) Postgraduate Research Coordinator and Research Fellow, Monash University; 9) Head of the Citarum Watershed Pollution and Damage Control Task Force; 10) Director of Bappenas; 11) Head of Settlement Infrastructure Division, West Java Provincial Housing and Settlement Office;12) Head of Water Resources Division, Bapperida Bandung Regency; 13) Principal Secretary for Infrastructure, Australian Embassy, DFAT; 14) Senior Program Manager, IPPIN; 15) Executive Director of YPBB (Yaksa Pelestari Bumi Berkelanjutan);16) Expert Team of the Citarum Task Force (Taufan Suranto); 17) Head of the Citarum Research Center, Padjadjaran University 18) Strategy & Engagement Manager, Urban Transformation Program Manager, Citarum Action Research Program 19) Vice Dean of the Faculty of Social and Political Sciences, Pasundan University); 20) Head of Housing and Settlement Office, West Java Province 21) Professor of Human Geography 22) Expert Team of the Citarum Watershed Pollution and Damage Control Task Force 23) EAWAG (Laura Velaques); 24) MADA 25) proBSF (26) Kibumi 27) UI Team
	Secondary Data – Reports, Government Official Documents	1. Official Report of the Citarum Harum Program 2. Citarum Harum Action Plan, 3. Citarum Working Paper – Agrarian Resources Center, 4. Presidential Regulation (Perpres) Number 15 of 2018 on the Acceleration of Pollution and Environmental Damage Control in the Citarum River Basin (DAS Citarum). 5. Previous studies about Citarum watershed related the study.	

Source: Processed by the authors, 2025

RESULTS AND DISCUSSION

Climate Justice Progress and Challenges in Citarum Watershed Governance

1. Just Transition

Just transition refers to the shift from a fossil fuel-based economy to a fair and regenerative renewable energy system. However, this transition is not solely focused on technological changes. It also emphasizes job opportunities in the renewable energy and environmentally friendly sectors, sustainable land use practices, and broader economic-political transformation (Center for Climate Justice, University of California, 2024). In the context of Citarum Watershed management through the Citarum Harum program, this transition is evident in the utilization of energy from Hydroelectric Power Plants (PLTA) in the Jatiluhur, Saguling, and Cirata reservoirs, among others. With a total energy capacity of approximately 2,600 MW, these hydroelectric plants support the national electricity grid and are designated as National Vital Objects (Bappenas, Kemenkomarves, Kementerian PUPR, 2024). The Cirata, Saguling, and Jatiluhur reservoirs in the Citarum Watershed play a strategic role as both hydroelectric power plants and public water bodies utilized by communities for freshwater fish farming (Bappenas, Kemenkomarves, Kementerian PUPR, 2024).

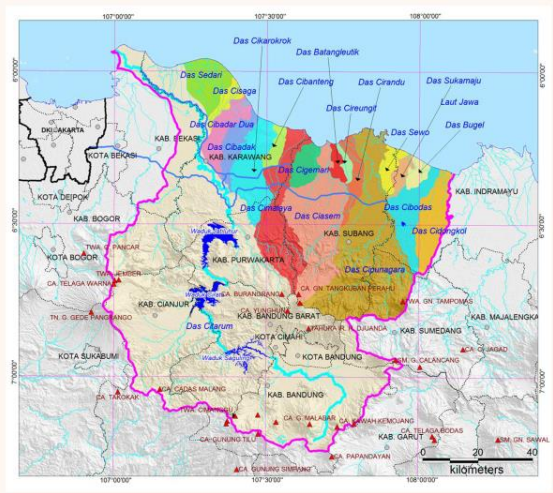

Figure 1. The 19 Watersheds/Sub-Watersheds in the Citarum River Basin

Source: Directorate General of Water Resources, Ministry of Public Works and Housing (PUPR), 2015

Eco-Friendly Technology in Citarum Watershed

Eco-friendly technology has been implemented in the revitalization of Floating Net Cages (KJA), with 21,792 units in Cianjur, West Bandung, and Purwakarta transitioning to more environmentally friendly technology (Bappenas, Kemenkomarves, Kementerian PUPR, 2024). To ensure the sustainability of the aquatic ecosystem, the government has introduced the Floating Net Cage (KJA) Management Program, focusing on structuring, management, and business conversion. As of 2023, a total of 26,789 KJA units have been organized, out of the targeted 141,219 units, which are expected to be completed by 2025 (Bappenas, Kemenkomarves, Kementerian PUPR, 2024; Satgas PKK DAS Citarum, 2019). Additionally, addressing critical land conditions in this region remains a priority through forest and land rehabilitation efforts, both vegetative and civil-technical, targeting 80,174.99 hectares by 2025 (Bappenas, Kemenkomarves, Kementerian PUPR, 2024). However, five major issues, including land ownership and soil management patterns, continue to pose significant challenges in this process (Widianingsih et al. 2024).

Strategies for Addressing Critical Land

Efforts to address critical land include various approaches based on land functions. In forestry, strategies involve nursery development, agroforestry, and forest protection. In agriculture, technology-based conservation and agroforestry patterns are the primary focus, while in plantation areas, initiatives include seedling multiplication and bench terrace construction. By 2023, these programs successfully rehabilitated 39,162.58 hectares out of the targeted 48,778.61 hectares, demonstrating significant contributions from various stakeholders in ecosystem rehabilitation (Bappenas, Kemenkomarves, Kementerian PUPR, 2024).

Reforestation

The contribution of the Indonesian National Armed Forces (TNI) includes the cultivation of 4,062,818 tree seedlings, the planting of 7,206,043 trees, the creation of 45,448 biopore holes, and the rehabilitation of 1,669 hectares of critical land. This collaboration strengthens the overall achievement of the targets, despite challenges such as managing community-owned land and 412.64 hectares of untreatable water bodies (Bappenas, Kemenkomarves, Kementerian PUPR, 2024). These efforts mark an essential step toward ensuring a sustainable energy transition and better ecosystem management in the Citarum Watershed.

Challenges in Just Transition

Citarum Watershed faces several challenges in realizing a just transition, ranging from the dominance of environmentally unfriendly industries that rely on fossil fuels—resisting renewable energy adoption due to high initial costs and low incentives—to the need to maintain

economic competitiveness without causing unemployment (ADB, 2023; Idris et al., 2019; Siswanto & Francés, 2019). Additionally, unsustainable land management, such as intensive agriculture that depletes soil and pollutes the river, necessitates a shift toward eco-friendly agricultural practices while maintaining farmers' productivity (Sumaryanto et al., 2021; Widianingsih, 2024; Narendra et al., 2021). Political-economic transformation remains a challenge, requiring governance reform, anti-corruption measures, and cross-institutional coordination to ensure transparent and inclusive policies (Nahib et al., 2024; Siregar & Wahyuni, 2023; Sulistyaningsih et al., 2021). Moreover, local communities heavily reliant on river resources often lack awareness or access to renewable energy technologies, necessitating capacity building for active participation. Lastly, substantial and sustainable funding for transition efforts remains a major constraint, especially given reliance on external donors, which is often unstable, highlighting the need for financing models that support long-term program sustainability in the region (Wahyuono & Julian, 20020; Susandi et al., 2024; Suryanta et al., 2021).

1.2 Social, Racial and Environmental Justice

The Citarum River in Indonesia exemplifies significant challenges in achieving social, racial, and environmental justice. The river has been severely impacted by pollution from various sources, notably the textile industry. Over 2,000 industries discharge pollutants, including heavy metals like lead, mercury, and arsenic, into the river daily, leading to the decimation of about 60% of its fish population since 2008 (Bappenas, Kemenkomarves, Kementerian PUPR, 2024; Satgas PKK DAS Citarum, 2019).

This environmental degradation disproportionately affects vulnerable communities, including small-scale farmers and industrial laborers, who rely on the river for drinking water, irrigation, and fishing. The contamination has led to health issues such as skin diseases and gastrointestinal disorders among residents (Salami et al., 2021; Astuti et al., 2024).

Efforts to address these injustices have been multifaceted. The Indonesian government initiated the Citarum Harum program in 2018, enlisting various stakeholders, including the Indonesian military, to restore the watershed. This approach has introduced new dynamics in watershed management, reflecting Indonesia's unique civil-military relations (Widodo et al., 2024).

Community-based initiatives have also emerged. For instance, environmental activist Fifie Rahardja founded the Bersinar Waste Bank, which incentivizes residents to collect and recycle waste by exchanging it for essential goods. This program not only reduces pollution but also empowers local communities economically. Despite these efforts, challenges persist. A study assessing the sustainability of ecovillages in the Upper Citarum watershed found that while cultural dimensions scored relatively high, ecological, economic, and social dimensions were rated as "poorly sustainable." This indicates a need for continued support from various stakeholders to enhance sustainability (Syamsiyah, 2023).

The Citarum Watershed faces significant challenges in achieving social, racial, and environmental justice, with disparities in access to resources such as clean water and fertile land being acutely felt by vulnerable groups, including small-scale farmers and industrial laborers. Pollution caused by industrial and domestic waste further exacerbates this situation, making essential resources inaccessible to them, while economically and politically powerful groups tend to secure unhindered access (Pitaloka et al. 2020; Juwana et al. 2022; Sadidan et al., 2024). Moreover, unjust development patterns widen social disparities, where marginalized communities bear the burden of pollution and loss of livelihoods, while the economic benefits of industrial activities in the region are concentrated in the hands of a few, creating inequities in the distribution of both benefits and burdens (Mudjiardjo et. 2021; Pitaloka et al. 2020).

1.3 Community Resilience and Adaptation (including Participation and Consultation)

Boer et al. (2019) found that most villages in the Citarum Watershed face significant climate risks like floods and droughts, requiring urgent adaptation efforts—25 villages need immediate action within 1 to 5 years, and 123 others within 5 to 10 years. Meanwhile, Nurwulandari & Rismana (2021) highlight limited healthcare access during floods in upstream villages but note strong community resilience, with locals demonstrating preparedness and social solidarity through effective survival strategies.

Through the Citarum Harum program, critical land rehabilitation efforts were carried out in 2023 to mitigate the impacts of climate change. One of the key activities involved planting Camellia sinensis (Sinensis tea) across 5 hectares of land, along with climate change mitigation and adaptation measures such as the construction of reservoirs, sheep pens, livestock farming, and composting facilities covering 35.1 hectares. This program aims to enhance the ecosystem's carrying capacity while simultaneously improving community well-being (Wardhana & Kusumawardani, 2023, Bappenas, Kemenkomarves, Kementerian PUPR, 2024).

By integrating adaptation actions with community resilience-building efforts, climate change mitigation initiatives in the Citarum Watershed are expected to be more effective. Special attention to the most vulnerable villages and a collaborative approach involving local communities are crucial to successfully managing the increasingly complex climate risks.

The Citarum Watershed faces major challenges in achieving community resilience and adaptation, particularly in terms of public participation and consultation, which involve social, economic, and environmental dimensions. The lack of local community involvement in planning often results in policies that feel disconnected from their actual needs, leading to resistance due to minimal understanding and engagement (Nahib et al., 2024; Siregar & Wahyuni, 2023; Sulistyaningsih et al., 2021; Siregar & Wahyuni, 2023). Information and educational disparities worsen the situation, as many community members, particularly small-scale farmers and traditional fishers, lack access to training or knowledge on eco-friendly adaptation practices, weakening their resilience to crises. Widespread poverty further hinders participation, as many families prioritize basic needs and are unable to engage in adaptation programs, especially without economic incentives (Narendra et al., 2021). Additionally, conflicts between community needs and large-scale industrial activities that pollute the environment exacerbate the issue, as corporations often wield significant influence over policies, sidelining community interests (Narendra et al., 2021). Inadequate adaptive infrastructure, such as clean water management systems and climate-resilient agricultural technologies, further limits the community's capacity to adapt. Weak institutional coordination and fragmented governmental agencies result in overlapping and ineffective policies, causing confusion at the community level regarding the various initiatives being implemented (Sulistyaningsih & Sari, 2021; Nahib et al. 2024).

1.4 Natural Climate Solutions, Climate Education and Engagement

The Citarum Ecotourism Living Lab (CELL) is a natural-based solution implemented in the Citarum River through a multi-stakeholder Pentahelix approach, involving universities (Universitas Indonesia, Monash University), government, local communities, industries, NGOs, and other stakeholders (Government of Padamukti Village, 2023; Government of Cibodas Village, 2023). Located in Cibodas Village, CELL focuses on addressing river and oxbow-related issues, waste management, economic empowerment through ecotourism and circular economy, and behavioral change in river management. As part of this initiative, the Citarik Ecotourism pilot project spans Padamukti and Cibodas Villages in Bandung Regency, promoting ecological preservation, economic development, and tourism based on the natural beauty of the Citarik River and local MSME businesses. Supported by the West Java Government, the Citarik Ecotourism master plan, developed by Universitas Indonesia and Monash University, aligns with the 12 key programs of the Citarum Watershed Management Plan (PPK DAS Citarum), covering critical land management, waste control, water quality monitoring, and public education (Government of Padamukti Village, 2023; Government of Cibodas Village, 2023).

Figure 2. Main Initiatives in Citarum Living Lab
Source: Government of Cibodas Village, 2023

Figure 2 explained that the Citarum Action Research Program focuses on five key initiatives to enhance sustainability in the Citarum Watershed. **Micro-economy promotion** supports local economic activities such as organic farming, aquaculture, horticulture, and livestock farming, rice farming and landscape amenity while encouraging a circular economy approach integrating water, food, horticulture, and waste management. **Solid waste services** involve community-based waste management and recycling of inorganic (plastic) and organic waste. **Waterway and landscape restoration** aims to rehabilitate aquatic habitats and ecosystem connectivity to improve biodiversity and habitat connections. **Water and sanitation** services focus on improving water quality, replenishing groundwater resources, and strengthening sanitation infrastructure. Lastly, **climate-change adaptation** includes ecosystem-based flood management and microclimate enhancement to improve resilience. These initiatives provide a holistic and integrated approach to sustainable watershed management, addressing environmental, social, and economic challenges in the Citarum Watershed.

The initiative also integrates climate education and community participation, but challenges remain in implementing Natural Climate

Solutions (NCS) —the use of natural processes to address environmental challenges like climate change— due to limited financial support, weak regulatory enforcement, and conflicts with industrial and urban expansion (Pitaloka et al., 2020; Nahib et al., 2024), Environmental degradation, including deforestation, river pollution, and declining soil quality, has reduced nature's ability to absorb carbon, mitigate floods, and preserve biodiversity, necessitating comprehensive restoration efforts. Additionally, low climate awareness among vulnerable groups (farmers and fishers) and limited access to climate information hinder mitigation efforts, making climate education integration into schools and community training programs a crucial step for increasing participation in climate resilience strategies (Hung, 2022; Siegner & Stapert, 2022; Leal Filho et al., 2021).

3.2. Social Equity Progress and Challenges in Citarum Watershed Governance

Social equity, economic efficiency, and environmental sustainability constitute the three pillars of Integrated Water Resources Management (IWRM) (Global Water Partnership, 2012). Equity frequently appears in discussions either supporting or opposing reforms in the water sector and remains a central issue in the fight against poverty. IWRM's social equity goal has been defined as ensuring equitable access to water and the benefits of water use among different social and economic groups, including men and women, the rich and the poor, both within and across countries, addressing issues of entitlement, access, and control (Lenton & Muller, 2009). In this study, the authors focus on key elements of social equity, including inclusive participation (Reed, 2008), fair resource distribution (Fraser, 1996; Peña, 2011), gender equality in watershed management (Agarwal, 2000), community capacity building (Pretty & Ward, 2001), transparency and accountability (Gonzales et al., 2009), conflict resolution mechanisms (Castro & Nielsen, 2001), community resilience and adaptation (Adger, 2000), and collaborative frameworks (Emerson, Nabatchi, & Balogh, 2012). Further explanation regarding the progress and challenges of social equity in Citarum Watershed Governance can be found in Table 2 below.

Table 2. Social Equity Progress and Challenges in Citarum Watershed Governance

No.	Social Equity Aspect	Progress	Challenges
1.	**Inclusive Participation** (Reed, 2008)	-Implementation of the **Pentahelix** model involving government, military, police, academia, private sector, communities, and media under **Presidential Regulation No. 15 of 2018**. -Increase in community-based organizations from **96 (2014) to 338 (2023)**, reflecting stronger local participation (BBWS Citarum, 2023).	**-Sectoral fragmentation** persists, with overlapping mandates and uncoordinated interministerial programs (Novalia et al., 2024; Chandra et al., 2019). **-Centralized decision-making** limits stakeholder influence, despite the Pentahelix model. **-Low female participation** in cooperative mechanisms affects project performance and inclusivity in water governance.
2	**Fair Resource Distribution** (Fraser, 1996; Peña, 2011)	**-Citarum's three reservoirs (Jatiluhur, Cirata, Saguling)** supply **irrigation, hydropower (1,880 MW), and drinking water**, benefiting **millions, including Jakarta's population** (Prawiranegara, 2020). - Irrigation water distribution supports **240,000 hectares of farmland** (ADB, 2009).	**-Water privatization** shifts control from communities to corporations, increasing irrigation costs (Prawiranegara, 2020). **-Reservoir infrastructure displaced over 13,000 families**, causing economic and social disruptions (Prawiranegara, 2020). **-High sedimentation rates threaten reservoir sustainability**, limiting long-term water availability (Prawiranegara, 2020).
3	**Gender Equality in Watershed Management** (Agarwal, 2000)	-Women contribute significantly to **agroforestry, crop maintenance, and community-based waste management initiatives (**Kinasih and Wulandari, 2022). -Programs like **TPS3R (Reuse-Reduce-Recycle Waste Management Center)** provide opportunities for women in environmental conservation (Bappenas, Kemenkomarves, Kementerian PUPR, 2024).	**-Limited female participation in agricultural decision-making** due to entrenched social norms (Qanti and Ihle, 2025). **-Gendered division of labor restricts women's involvement** in critical watershed governance roles (Qanti and Ihle, 2025).
4	**Community Capacity Building** (Pretty & Ward, 2001)	-Environmental Health Education in **154 schools,** -Training and mentoring for **80 environmentally friendly schools,** -Outreach programs for community educators, including POSYANDU and PKK cadres, as well as village facilitators. -Community engagement forums empowered through **capacity-building initiatives** (Bappenas, Kemenkomarves, Kementerian PUPR, 2024).	**-Low environmental awareness** hinders sustainable behavior change. **-Budget and technical resource constraints** limit training and waste management efforts. **-Weak enforcement of environmental regulations** fosters non-compliance.
5	**Transparency and Accountability** (Gonzales et al., 2009)	-Establishment of a **Command Center for data collection, monitoring, and public engagement**. **-516 water quality monitoring points** and **7 media platforms** for public awareness. **-7 public awareness media platforms** operational, **-A media analytics system with 5,071 news articles published**, including **2,980 positive, 1,056 negative, and 1,035 neutral reports**, **-117 community complaints addressed** via **social media (29 cases) and hotline services (88 cases)**, **-2,090 social media posts** across platforms including **Instagram (576 posts), Facebook (576 posts),**	**-Fragmented data management** among agencies leads to inefficiencies in transparency. **-Weak public engagement in oversight** due to low literacy on environmental rights and decision-making processes. **-Government-dominated governance limits inclusivity**, despite the Pentahelix framework.

		Twitter (565 posts), and TikTok (373 posts), **-1 public engagement event**, and **-8 audiovisual productions for NGONCI (Ngobrolin Citarum).** (Bappenas, Kemenkomarves, Kementerian PUPR, 2024).	
6	**Conflict Resolution Mechanisms** (Castro & Nielsen, 2001)	- **Adaptive governance strategies** applied to manage water conflicts (Porras et al., 2020; Porras et al., 2019; Santiago & Hong, 2019; Chu et al., 2014). -Formation of **watershed management committees** facilitates stakeholder dialogues (Gonzalez, 2024; Dhiaulhaq et al., 2017).	**-Lack of effective mediation mechanisms** results in unresolved disputes. **-Top-down policies often neglect local knowledge**, leading to resistance to government interventions (Sulistyaningsih & Sari, 2021; Nahib et al., 2024).
7	**Community Resilience and Adaptation** (Adger, 2000)	**-Citarum Living Lab and Citarik Ecotourism Master Plan** integrate sustainability with local economic development (Hadfield et al. 2024; Monash University 2023, Pemerintah Desa Padamukti, 2023). **-Integrated waste management systems** improve pollution control in villages (Hadfield et al. 2024; Monash University 2023, Pemerintah Desa Padamukti, 2023). **-Participatory Design Workshops** engaging community members in the design and implementation of environmental solutions ensures that interventions are culturally appropriate and widely accepted (Monash University 2023, Pemerintah Desa Padamukti, 2023).	**-Limited infrastructure and funding** for climate adaptation measures (Sulistyaningsih & Sari, 2021; Nahib et al., 2024). **-Slow transition to sustainable livelihoods** due to economic dependency on polluting industries (MoEF, 2020). **-Low female participation** in community resilience programs reduces inclusivity (Sulistyaningsih & Sari, 2021; Nahib et al., 2024).
8	**Collaborative Frameworks** (Emerson, Nabatchi, & Balogh, 2012	**-Pentahelix model institutionalized under Ministerial Decree No. 1530/KPTS/M/2023**, establishing a **Citarum Watershed Coordination Team (TKPSDA WS Citarum)**. (The committee consists of 50 members, divided into two categories: Government representatives, including officials from West Java Province and 12 city/regency governments (25 people) and Non-government representatives, including community leaders, academics, and private sector representatives (25 people). -Involvement of **government, academia, private sector, and communities**.	**-Sectoral governance and weak inter-agency coordination** hinder integrated watershed management. **-Stakeholder engagement remains limited**, with government dominance in decision-making processes. **-Public trust and communication barriers** continue to challenge governance effectiveness.

Source: Various sources processed, 2025

DISCUSSION

This study examines the complex relationship between climate justice, social equity, and climate change adaptation in the Citarum Watershed, revealing both progress and ongoing challenges that are essential for understanding sustainable environmental governance in the region. The findings highlight how climate change impacts, environmental degradation, and social inequalities are deeply interconnected, affecting marginalized communities the most.

A significant aspect of climate justice identified in the study is the transition from fossil fuels to renewable energy within the watershed, with Hydroelectric Power Plants (PLTA) at Jatiluhur, Cirata, and Saguling reservoirs being key examples of this shift. These plants provide important contributions to the national grid and are part of the region's efforts to reduce reliance on fossil fuels. However, the transition remains uneven, as many local communities who depend heavily on natural resources face barriers in accessing renewable energy technologies. This issue is compounded by low awareness and sustainable funding challenges, limiting the ability of these communities to actively participate in the energy transition (Wahyuono & Julian, 2020; Susandi et al., 2024). Moreover, the dominance of industries that rely on fossil fuels continues to resist change, hindering the widespread adoption of renewable energy solutions.

Regarding reforestation efforts, the Indonesian National Armed Forces (TNI) have played a key role in cultivating over 4 million tree seedlings, planting over 7 million trees, creating biopore holes, and rehabilitating 1,669 hectares of critical land. Despite challenges such as managing community-owned land and untreatable water bodies, these initiatives are a crucial step toward a sustainable energy transition and improved ecosystem management in the Citarum Watershed (Bappenas, Kemenkomarves, Kementerian PUPR, 2024). This highlights the importance of ecosystem restoration alongside the energy transition as part of a holistic approach to climate justice and sustainability in the region.

In addition to this, industrial pollution—particularly from the textile sector—has caused severe damage to the Citarum River, which is vital for the livelihood of local farmers and laborers who depend on it for drinking water, irrigation, and fishing. This pollution has not only led to the contamination of the river but also to significant health issues among the communities living along the watershed. Vulnerable groups, including small-scale farmers and workers in nearby factories, bear the brunt of this environmental degradation, which disproportionately affects their access to clean water and fertile land. The study shows that while the benefits of industrial activities are concentrated in the hands of the powerful, the environmental and health burdens fall on the marginalized. This scenario underscores the need for policies that incorporate social justice principles to ensure equal access to resources and decision-making opportunities for marginalized communities (Salami et al., 2021; Astuti et al., 2024).

The study also highlights the social equity challenges faced by local communities in the Citarum Watershed. One of the most significant findings relates to the inclusive participation of these communities, which has been encouraged through the Pentahelix model, a collaborative governance approach involving government, the military, academia, the private sector, and local communities. While this model has led to some positive changes, such as an increase in community-based organizations, sectoral fragmentation and centralized decision-making remain significant barriers. Government dominance in the decision-making process often limits the participation of local communities, especially marginalized groups. This power asymmetry results in the exclusion of vulnerable communities from key decisions affecting their environment and resources (Sulistyaningsih et al., 2021). In particular, gender inequality persists in the management of the watershed, with women playing a crucial role in environmental conservation efforts, yet their involvement in decision-making remains limited due to gendered divisions of labor and deep-rooted social norms (Qanti & Ihle, 2025). The study shows that low female participation in watershed governance roles continues to hinder efforts to achieve more inclusive and equitable resource management.

Moreover, the unequal distribution of resources, particularly water, is a significant issue. While the region's major reservoirs provide vital resources such as irrigation, drinking water, and hydropower, control over these resources is increasingly shifting from local communities to private corporations, especially with the privatization of water. This shift has led to rising irrigation costs for small farmers, worsening the social inequities faced by these communities (Prawiranegara, 2020). Additionally, sedimentation in the reservoirs poses a long-term threat to water availability, further exacerbating the unequal distribution of resources (Prawiranegara, 2020). This dynamic underscores the need for policies that ensure more equitable access to water, particularly for those who rely on it for their livelihoods.

The study also directly addresses the issue of climate change impacts in the Citarum Watershed, with communities facing significant risks from flooding and droughts as a result of unpredictable

rainfall patterns and increasing temperatures. According to the study, 25 villages within the watershed require urgent adaptation actions within the next 1 to 5 years, and 123 villages will need interventions within the next 5 to 10 years (Boer et al., 2019). These climate risks further exacerbate the vulnerability of already marginalized communities, particularly those in upstream areas who experience limited access to healthcare during floods (Nurwulandari & Rismana, 2021). The increasing volatility of the climate puts additional pressure on local populations who are already struggling with economic and social challenges.

In response to these climate risks, several adaptation measures have been implemented, such as the Citarum Harum program, which focuses on land rehabilitation, ecosystem restoration, and improving community resilience. This includes actions like planting climate-resilient crops, constructing reservoirs to manage water resources more effectively, and building facilities for livestock farming and composting to support sustainable agricultural practices. These initiatives aim not only to mitigate the impacts of climate change but also to enhance the watershed's resilience to extreme weather events. Furthermore, natural climate solutions (NCS) such as reforestation and sustainable land management are being explored to help restore ecosystems and mitigate the effects of climate change on the region (Hadfield et al., 2024). The Citarum Living Lab and Citarik Ecotourism Master Plan are integrating climate education and community-based climate adaptation strategies to build long-term resilience and promote sustainable practices among local populations (Monash University, 2023; Pemerintah Desa Padamukti, 2023).

However, these adaptation efforts face significant challenges. Sectoral fragmentation, power imbalances, weak policy integration, weak infrastructure, limited funding, and unequal participation (since many marginalized communities lack access to participation), remain significant barriers to effective watershed governance. Many programs operate independently, leading to inefficiencies and overlaps in implementation. Moreover, the participation of women in decision-making is still limited hinder the full effectiveness of climate change adaptation programs (Pitaloka et al., 2020; Nahib et al., 2024). Moreover, low climate awareness among vulnerable groups, such as farmers and fishers, along with limited access to climate information, prevents effective participation in adaptation efforts (Hung, 2022; Leal Filho et al., 2021). These barriers highlight the importance of integrating climate education into local communities and ensuring that adaptation strategies are tailored to the specific needs of vulnerable groups.

In conclusion, the study reveals that climate justice and social equity are deeply interconnected issues within the Citarum Watershed. As the region faces escalating climate risks, efforts to improve environmental governance must be inclusive, equitable, and adaptive. Addressing the barriers to renewable energy access, gender inequality, and resource distribution, while simultaneously enhancing climate change adaptation strategies, will be critical for building resilience and ensuring a fairer and more sustainable future for all communities in the watershed.

Furthermore, the increasing frequency of natural disasters, such as floods, landslides, and earthquakes, poses additional threats to Citarum Watershed governance. Deforestation, urban expansion, and poor land-use planning have exacerbated soil erosion and sedimentation in reservoirs, reducing their capacity to manage floodwaters. Climate change-induced extreme weather events further intensify the risks of flooding and landslides, particularly in upstream and densely populated areas. Additionally, seismic activity in West Java, where the watershed is located, increases the vulnerability of infrastructure and communities. Addressithese challenges requires integrated disaster risk reduction strategies, including reforestation, improved watershed management, sustainable urban planning, and investment in resilient infrastructure. Strengthening early warning systems, emergency response mechanisms, and community disaster preparedness will be crucial in ensuring that Citarum Watershed governance is not only socially equitable but also climate-resilient and disaster-responsive.

Sustainable Watershed Governance in Realizing Climate Justice and Social Equity

Sustainable watershed governance in the Citarum Watershed can significantly contribute to climate justice and social equity through a multisectoral approach that integrates environmental management, stakeholder participation, and equitable resource distribution. As one of the most critical watersheds in Indonesia, the Citarum Watershed faces severe challenges due to pollution, deforestation, and socio-economic disparities among communities. Implementing sustainable governance practices can address these issues by fostering stakeholder collaboration and ensuring that the benefits of watershed management are fairly distributed.

First, effective watershed governance emphasizes the importance of stakeholder engagement, which is essential for achieving social equity. A collaborative governance model

involving local communities, government institutions, and non-governmental organizations (NGOs) can enhance participation and ensure diverse voices are heard in the decision-making process. This participatory approach not only empowers marginalized communities but also leads to more informed and equitable management decisions that reflect the needs and priorities of all stakeholders (Novalia et al., 2024; Chandra et al., 2019).

Furthermore, sustainable watershed governance can facilitate the equitable distribution of resources and the benefits derived from watershed management. By adopting an integrated hydro-economic model, policymakers can identify areas where past management practices have failed and implement strategies that promote both environmental sustainability and social equity (Alamanos et al., 2019). Such models can assist in assessing the socio-economic impacts of water management decisions, ensuring that vulnerable populations are not disproportionately affected by environmental degradation or resource allocation (Roy & Berke, 2022). For instance, establishing fair water pricing mechanisms and providing financial support to underprivileged communities can improve access to clean water and enhance overall quality of life (Marzola et al., 2022).

Additionally, addressing negative externalities associated with watershed management is crucial for achieving climate justice. Governance frameworks must incorporate mechanisms that account for the distributive consequences of environmental policies, particularly in flood-prone areas where low-income communities are often the most affected (Roy & Berke, 2022). By recognizing and mitigating these externalities, governance structures can enhance resilience and adaptive capacity among vulnerable populations, leading to a more just response to climate change (Zhang, 2024).

Thus, sustainable watershed governance in the Citarum Watershed can foster climate justice and social equity by promoting stakeholder participation, ensuring equitable resource distribution, and addressing negative externalities in environmental policies. By integrating these principles into watershed management practices, it becomes possible to build more resilient and equitable communities that can effectively address the challenges posed by climate change.

CONCLUSIONS

This study emphasizes the critical need to integrate climate justice and social equity into the governance of the Citarum Watershed to ensure both environmental sustainability and the improvement of local livelihoods. While programs like Citarum Harum have made progress, persistent challenges remain in fair resource distribution, inter-agency coordination, and inclusive community participation. The transition to renewable energy, especially hydropower, offers significant promise but requires overcoming obstacles such as sedimentation and ensuring equitable benefits through infrastructure rehabilitation and community empowerment. Social equity is also a major concern, as marginalized groups often lack the power to participate in decision-making processes, highlighting the need for more inclusive, community-based approaches. These approaches should be complemented by education and incentives aimed at building climate resilience. Nature-based solutions, such as those provided by the Citarum Living Lab, have potential but depend on stable policy frameworks and consistent funding. Effective governance should combine technical solutions with transparent, accountable collaboration, particularly as natural disasters become more frequent and severe.

To promote social development, governance frameworks should focus on inclusive participation, decentralizing decision-making, and ensuring equitable access to resources. Empowering local communities with education, financial support, and access to technology is crucial to fostering sustainable practices. Special attention should be paid to gender equality, with efforts to place women in leadership roles in watershed management. Long-term policies must prioritize economic resilience and climate adaptation, ensuring that the most vulnerable populations are included in decision-making processes. The study acknowledges its focus on Bandung Regency and recommends future research to extend data collection across the entire watershed for a more comprehensive understanding of governance challenges and opportunities. Ultimately, this study underscores the interconnectedness of climate justice, social equity, and governance, asserting that achieving a just transition requires addressing systemic inequalities while enhancing institutional capacities for meaningful stakeholder engagement. By fostering community-driven solutions, the Citarum Watershed can become a model of inclusive and sustainable management, ensuring that marginalized voices are heard and development benefits are equitably shared.

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